SOME FACTORS IN PLANNING FOR FUTURE MILITARY DATA AUTOMATION SYSTEMS

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I. INTRODUCTION

The year 1966 may well go down in the annals of the military data automation community as the Year of the Master Plans. Comforting as this thought may be--for it is helpful to have a clear blueprint of the tasks the future holds--it is not clear that 1966 will also be known as the Year of the Reconciliation of the Master Plans. And until such co-ordination of master plans is effected within the military services, throughout the Department of Defense, and, yes, possibly across the entire structure of the U.S. Government, it appears unlikely that the master plans of 1966 can hope to serve as blueprints for more than a year or two of the future. Coordination of master plans is not easily effected, and because of the potential controversy involved, the subject is not to be lightly broached. But it has been demonstrated many times that once government spending for a single identifiable function or item or utility becomes a substantial percentage of the budget, more cooperation and less duplication of effort is demanded on the part of all agencies involved. As a typical example, communications services--first within the DOD and now within the government in toto--are coming under increasingly greater scrutiny to ensure economy and efficiency

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of service and operation. Government interest in close supervision of all of its data automation facilities and services is either entering or will soon enter this same phase. The Bureau of the Budget's yearly publication, "Inventory of Automatic Data Processing Equipment in the Federal Government," is a first step in that direction.

Each organization finds a master plan for the future a necessary and useful tool for internal planning purposes, but coordination of the master plans of several different organizations--each plan separately conceived--may be a painful and trying experience for all concerned. However, successful coordination of planning efforts can provide much greater stability and effectiveness of the composite of efforts. This Paper will not proffer suggestions that will necessarily ease the burden of data automation master plan coordination, but, because it is intended not as a presentation, but as a vehicle to stimulate discussion, the Paper will attempt to raise some of the broad issues that at all levels face the designers of master plans, or plans that coordinate master plans. The treatment of these issues in the Paper will be kept as objective as possible; it will be left to the discussants at the Third Congress to take sides and do battle.

To achieve the goal of delineating some future trends of military data processing and to indicate some of the potential effects that master planning and the coordination of master plans might have on these trends, in the remainder of this Paper I will first undertake to categorize the functional uses of data processing by the military; ~~next,~~ the relative scope of data automation activities by the services ~~will be~~ outlined; ~~third,~~ a few of the dichotomies ~~(or paradoxes?)~~ facing master planners ~~will be~~ discussed; ~~then~~ some of the potential bottlenecks that may slow the desired progress of data automation improvement ~~will be~~ listed; and, ~~finally,~~ some summarized suggestions of future planning efforts ~~will be~~ presented.

II. MAJOR MILITARY USES OF DATA AUTOMATION

In the military, as elsewhere, the user of data automation sees its greatest utility and future as an aid to him in <u>his</u> work. Understandably, the user frequently thinks that <u>he</u> is making the very best

use of his machine and that improvements and advances stem foremost from his efforts. And the user's data processing equipment often is sufficiently flexible to allow the user to branch into activities similar to those of other organizations or agencies; this has a tendency to engender competition and rivalry. Thus, in categorizing the uses to which the military applies data automation, it is recognized that some overlap will exist and that these overlaps may fall in areas where today competition and rivalry may exist. For the purposes of this Paper, five major military uses of data automation are considered, although it is quite likely that others could be cited:

- o Research and Planning Systems
- o Management Systems
- o Support Systems
- o Command Systems
- o Tactical Systems*

Research and planning data automation systems include those at military laboratories and, typically, the system recently proposed for use by the Air Staff for preparation of plans and the formulation of staff positions. Ultimately, the research systems at the laboratories may be widely internetted; a plans system for the Air Staff might have, in addition to an information display center, remote connections to the deputy chiefs of staff and appropriate directorates, as well as connections that make available information from the data base of other systems.

Management systems are taken to be those that recurringly perform essentially the same tasks, whether in peace or crisis, that are necessary for the normal functioning of a large organization, viz., finance and accounting, personnel records, logistics, etc. Generally, elements or branches of such systems are to be found at every major military installation.

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*Special-purpose computers, such as those used in missiles, are not included.

Support systems are typified by those in use by the Air Weather Service, the photocomposing system for document publication soon to be installed at Wright-Patterson Air Force Base, etc. Support systems characteristically have one or a very few large data processing facilities and a very large number of users of their output.

Command systems have sometimes been described as "capping" systems, for they are apt to make use of the outputs of planning systems, management systems, and support systems. In the future, as tactical computer systems become more prominent, upper echelon command systems will likely make real-time use of summarized data from them. In a sense, command systems either are, or should be capable of, mustering, allocating, and directing resources to meet military commitments--both potential and actual--throughout all levels of crisis and war. Of course, this broad charter places the command system in the position of overlapping the functional areas of planning, management, and (sometimes) support. And, with the present worldwide politico-military environment directed toward controlled escalatory warfare, it is inevitable that even upper echelon command systems will occasionally encroach on some control functions of tactical systems.

It is, of course, impossible to avoid functional overlap in establishing a category of tactical data automation systems. It may be desirable to categorize tactical systems as those in use by field forces (whether in the field or in garrison training), or to say that tactical systems are mobile, ruggedized, and, hopefully, small and lightweight. But probably the best differentiation possible is to say that tactical systems are those used by field forces, and not already covered by one of the other four categories. Thus, elements of SAGE and BUIC, shipborne and airborne systems, as well as units that may be carried into combat, such as the Field Artillery Digital Automatic Computer (FADAC), are included. In general, data processors that are integral parts of weapon systems and are essentially special purpose (e.g., inertial navigation computers) are not included here.

Is it necessary to have this categorization of functional uses of data processing by the military? The answer is "Yes," and for at least two reasons. The first reason is that the attempt at categorization

points up the extreme difficulty of looking in a meaningful fashion at just one part of the military data automation picture. With rare exceptions it is simply not possible (or, at least, not effective or efficient) to consider one category of military application of data automation (e.g., command systems) without being cognizant of, and coordinating with, activities in most of the other areas. Certainly this is true for many tactical applications, for often they either are now or in the future will be primarily duplications of efforts that are already handled by data processing systems that are not capable of field deployment, e.g., the possible future use of data processors in backup airborne command posts.

A second reason for some form of categorization stems from the needs of higher echelon organizations to delineate similar characteristics for comparison of the efficient use of data processing systems. For example, the DOD must at some point view the use of data automation by the three services in some comparative fashion, asking the question. "Are systems of comparable capability being utilized with equal effectiveness?" The measures of utilization may be difficult to establish, but, once established, should the answer in any instance be negative, remedial action would be needed. In the same manner, an appropriate organization looking broadly across all U.S. Government uses of data automation for the purposes of coordination leading to efficient employment of data automation throughout all government agencies must also seek some means of categorization for comparison and, hopefully, coordination.

III. THE RELATIVE SCOPE OF MILITARY USES OF DATA AUTOMATION

What is the relative effort that is invested in providing military data automation? Some statistics on this question may help to provide some insight into future trends of military data processing. The estimated total number of installed computers operating under the aegis of the U.S. Government at the end of FY66 was about 2500.[1] This represents about 9 percent of the total number of computer installations in the country at that time. Extrapolating available data to the present, the DOD makes use of about 1900 computers, of

which about 53 percent are under control of the Air Force, with the Army and Navy controlling 22 percent and 21 percent, respectively.* The direct cost of data automation (with support) to the U.S. Government has been over a billion dollars for each of the last three fiscal years. Thus, about one percent of the national budget is directly attributable to government data automation. The DOD accounts for about two-thirds of the U.S. Government's installed computers and about 61 percent of its computer costs. Some of these relationships are illustrated in the figure, which shows the recent growth of installed and on-order computers in the United States, installed computers in foreign countries, and installed computers under the control of the U.S. Government, the Air Force, the Army, and the Navy.

It is noteworthy that although this nation has been installing additional computers at the rate of 7250 per year for the past two years, the U.S. Government rate has been only about 300 additional computers per year, with the Air Force accounting for slightly more than one-third of the new additions each year and the Army and the Navy each accounting for about one-sixth or less of the total government rate. This should probably not be surprising, for the military services had priority in filling their needs during the early years of data automation growth, and although computer replacements continue apace in military installations, the rate of additional computer acquisition is not in keeping with that of the nation.

It has often been said recently that the impact of government--and especially military--spending on the computer industry is continually dwindling. The figure might be construed to substantiate that claim, for at end FY66 the U.S. Government will operate less than 7 percent of the nation's installed computers; two years previously it operated over 9 percent. Should present trends continue for the next two years, the U.S. Government's share will drop to about 5.5 percent.

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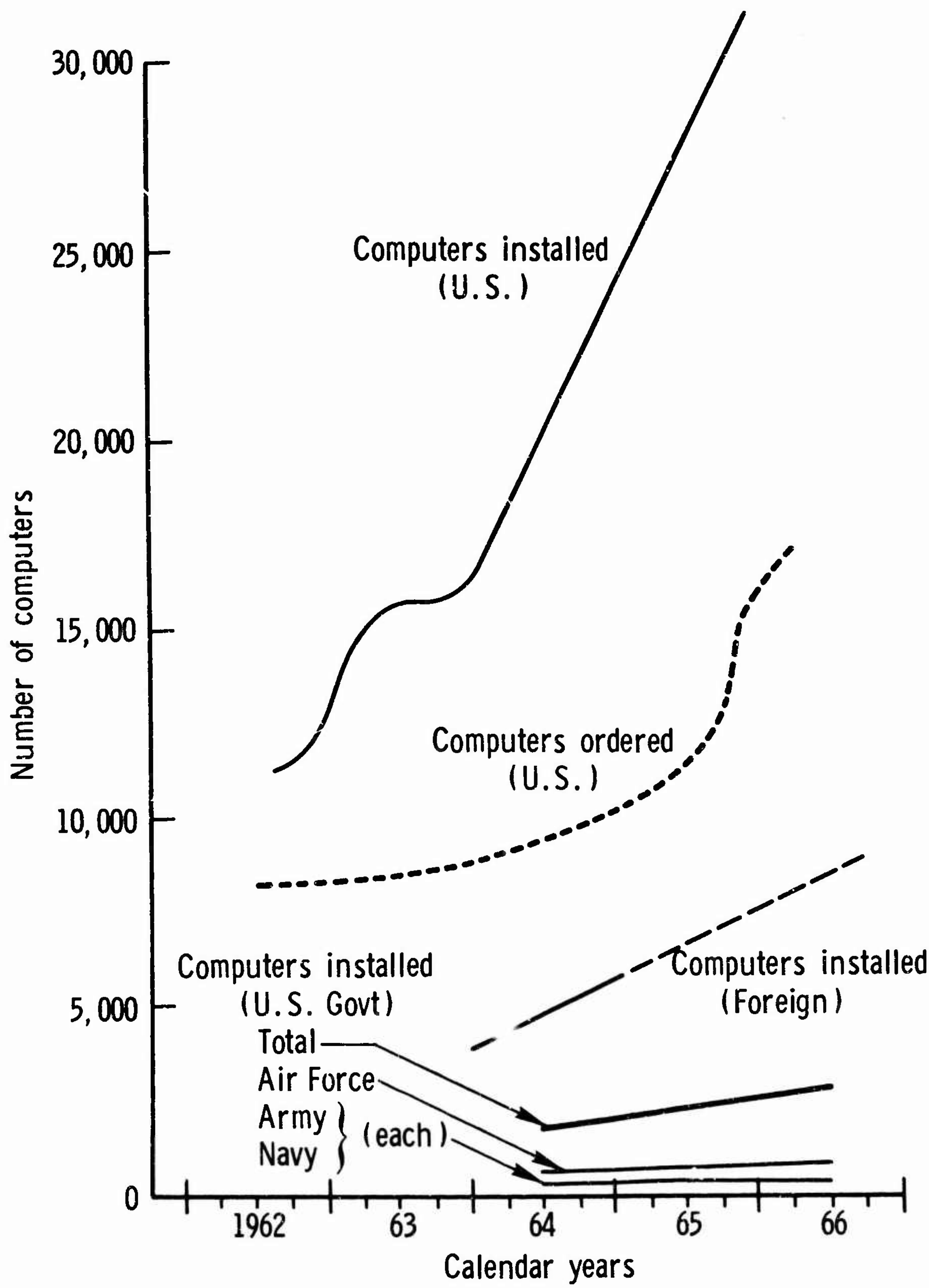
*The data presented here include some tactical computer installations such as SAGE and BUIC sites. They do not include airborne or shipborne computers or field mobile units such as FADAC.



Growth of data automation

In broad geographical terms, where do the military services make use of data automation? Table 1 shows the number of major geographical locations of military data automation locations.(1)

Table 1

DISTRIBUTION OF MAJOR LOCATIONS OF U.S. MILITARY DATA PROCESSING

Military Service	Major U.S. Urban Areas	Foreign Countries	Total
Air Force	126	17	143
Army	75	4	79
Navy	46	4	50

Within the United States, the regions with the highest density of military computers are Washington, D.C., San Francisco, San Antonio, Philadelphia, Norfolk, Virginia, and Dayton, Ohio. It follows that each of these regions would be prime candidates for the on-line service that may someday be provided by a data automation "utility" system, i.e., a system that might supply on-line computing power from a central facility to all military customers within a specified geographical area. As an aid to visualizing the potential scope of military data automation utility systems, Table 2 indicates the degree of gross collocation of military computers within the United States. It is stressed that collocation is taken here to mean computer installations within a general urban area, i.e., within at least a few tens of miles of each other.

Table 2

DISTRIBUTION OF COLLOCATED MILITARY DATA PROCESSING IN THE UNITED STATES

Military Service Combinations	Major U.S. Urban Areas
Air Force-Army-Navy	9
Air Force-Army (only)	21
Air Force-Navy (only)	11
Army-Navy (only)	4

Table 2 indicates that possibly one-third of the Air Force's data automation U.S. locations might be able to share a local-area military data automation utility system with one or more of the other services. Should it be possible to serve a large geographical area with the utility, obviously even more installations could be supported. Of course, data automation utility systems present certain problems and drawbacks when applied to military tasks, but indications are that commercial applications of these systems will become more prolific in the future and it is likely that the military will find it necessary to evaluate at least the potential use of utility systems, both for individual service applications and for joint service use. More will be said about this later.

The discussion on scope of military data automation thus far has centered on fixed computer installations, thereby excluding most tactical applications. Although the figure makes evident that the growth of fixed military computer installations is moving ahead at a relatively moderate pace, it gives no indication of the future growth of the the use of data automation for tactical purposes.*

Although it is doubtless true that no accurate estimates can be made of the degree to which military data automation may ultimately be applied in tactical units, it is perhaps of some value to make a gross reckoning of the number of identifiable military units to which data automation may be applied in the near future. An estimate of this kind is given in Table 3, which also indicates a range in the number of computers that might actually be involved. To avoid security difficulties, U.S. force size has been based on an unclassified source.[2]

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*The computers considered for tactical purposes are assumed to be of the micro-miniaturized general-purpose variety, costing possibly $30,000 to $150,000 today. Although no one of these computers would satisfy all tactical needs, it is assumed that a computer of this type could be of great use in many tactical applications, if appropriate peripheral equipment and software could be made available.

Table 3

POTENTIAL FUTURE USE OF TACTICAL MILITARY COMPUTERS

Military Service or Branch	Unit	Number of Units	Tactical Computers per Unit	Total
Air Force	A/C Sqdn	200-250	1-2	200-500
Army	Division	16-19	20[a]	320-380
Navy	Ship/Sub	400 450	1-2	400-900
	A/C Sqdn	60-70	1-2	60-140
Marine Corps	Division	3-4	20	60-80
	A/C Sqdn	15-20	1-2	15-40
Grand Total				1055-2040

[a]Already acquired FADAC computers not included.

How reasonable are the totals shown in Table 3? That question is essentially impossible to answer and the totals can be considered only as opinion, but some of the assumptions underlying the totals and some of their implications can be discussed. The use of military data processing in tactical environments has long been stated as a military requirement by the services. However, only in recent years has the state of technology permitted the production of data processors sufficiently small and reliable to be seriously considered for field use. Acceptable peripheral equipment to work with the central processing unit and appropriate software are today probably the pacing items that delay system applications. Of course, not all so-called tactical applications represent the worst of all possible operational environments; for example, many shipboard applications and ground applications associated with aircraft squadrons may present much more benign environments than can be expected for equipment taken by Army and Marine units into active ground combat zones. Implicit in some of these comments is the assumption that it will be desirable (and, hence, required) to make identifiable military fighting units down to

at least the division, ship, and squadron level essentially independent of higher echelons for at least a major portion of their tactical data automation capability. It is possible that the successful demonstration of a field service tactical data automation utility system could reverse this assumption and that the computing power of large central processors, rather than organic computers, would be used remotely by lower echelon units. The mobile communications netting task, although not technically infeasible, would be formidable for a tactical utility system. In general, the need to maintain autonomous capability in the operation of field units will likely keep the pressure high for separate computers.

In terms of the earlier categorization of the use of military data processing, it would appear that tactical uses could easily duplicate all of the other categories listed above. (Should enough computer power be available in the field, it is to be anticipated that some of it would be relegated to certain operations research functions.) Not only that, but it is likely that in some instances command and control, planning, management, and support functions will all be carried out in the same data automation installation, e.g., aboard ship, or organic to the tasks of the aircraft squadron.

To some degree, the data processor organic to the lower echelon tactical unit may itself be the central element of a small remote I/O tactical system, for the success of application of data automation to tactical units may well hinge on the ability to acquire information remotely in digital form, process the information, and send processed results or further queries to lower or higher echelon units. The successful completion of recent tests employing a digital message entry and acknowledgment device at lower echelons, and buffered and printed output at higher echelons, has indicated the advantages and feasibility of some elements of a small tactical system with remote input/output.* It remains to be demonstrated that a central processor

*Tests consisted of sending and acknowledging forward air controller messages and were conducted at the Tactical Air Warfare Center, Eglin Air Force Base, Florida.

unit and appropriate software can be added to complete this application of data automation to one part of a tactical air control system. If a complete system can be made reliable and successfully demonstrated in the field, similar applications in other areas and by other services will likely depend more on the generation of software than on equipment.

IV. PITFALLS AND DICHOTOMIES IN PLANNING FOR MILITARY DATA AUTOMATION SYSTEMS

The road to be followed by planners of future military data automation systems promises to be a rocky one. The requirements for future military data automation systems will likely continue to include, to some degree, the long-standing requirements that sometimes seem almost paradoxical: efficient and economical, evolutionary, flexible, and survivable. These requirements, coupled with the great geographical coverage--often worldwide--required of many systems, pose system planning tasks that are indeed formidable. The recently acquired third-generation hardware capabilities have created further problems for the planner by affording various alternatives that may be employed to satisfy military system requirements; one pair of alternatives was implicitly mentioned above in the discussion of tactical data automation and is discussed in more detail below.

UTILITY SYSTEMS: YES, NO, OR HOW MUCH?

Probably the biggest single question facing the planner of future systems concerns the choice of using a utility system with a large central data processor and remote input/output or of using several smaller (but not necessarily "small") data processing installations at each of the major I/O locations. At the moment there are no good guidelines available to help the planner in making this choice, for even special-purpose utility systems, such as the Keydata Corporation system in the Boston area, are just beginning to provide operational information.[(3)] A corollary question facing the planner concerns the

size of geographical coverage to be provided by a utility system; this is closely associated with the further question, should the utility system provide capability to more than one military service within a given geographical area? This question has been broached earlier in this Paper, when it was pointed out that there are certain areas in the United States where a heavy concentration of military data automation is to be found. Under selected circumstances--notably, those associated with universities and colleges--early models of utility systems appear to be working well and the users seem to be more satisfied than not. In installations at institutions of higher learning, the utility system is often used partially in a time-shared mode by several instructors with remote I/O stations in the classrooms, partially by research teams (sometimes to monitor physical experiments in real time), partially for graduate thesis work, and partially by the institution for accounting, payroll, etc. As single utility systems come to provide more and better services than do many small machines, perhaps one of the most obvious locations for a military prototype system would be in the Pentagon. A Pentagon prototype utility system that would serve all the services would call for a new level of cooperation among the users and might serve as a useful guide for military utility systems elsewhere. Of course, a Pentagon utility system may be seriously constrained should it be necessary to provide for secure transfer of information throughout the building. For military applications, the task of providing high security for the transfer of high data rate digital information is one demanding early, economical solution. The technology to handle this task is in hand; but, as yet, it is not as economical as it must become.

In at least one case, preliminary results concerning a utility system indicate that it is efficient for the user in providing low cost real-time service comparable to that of an on-site installation.[3] Will utility systems afford the military user the flexibility needed? The answer to this question is closely intertwined with military missions, especially during crises and/or wartime. In commercial or educational utility installations, it is conceivable that a crisis affecting one or several users of the system would have little effect

on many of the other users, or under certain circumstances various users could reduce their activities. Almost the converse is true for the military users. A crisis that affects one military service is apt to have a similar effect on other military users sharing the system, thus bringing demands by all users to a peak. Difficult though it may be to demonstrate by means of cost-effectiveness, the military need for flexibility in time of stress may surmount what appears to be the obvious advantages to be gained in efficiency of operation by the use of utility systems. Of course, the utility system might be designed to accommodate any expected peak loads. However, often it is possible to generate meaningful system design tests by actual crisis operation only, wherein a design failure may be found too late and prove to be catastrophic.

Another potential application for the utility system concept is at the base level. Today almost all major military bases are apt to have two or more separate computer installations. As more and more functional military areas--maintenance, medicine, communications, etc.--turn to data automation for improved operational performance, the number of computers at each base may greatly increase--unless the additional capability can be provided by a base data automation utility system. Of course, here again loom the twin specters of system flexibility and survivability. As the nation's military policy continues to swing toward developing a capability for mobility and responsiveness of more and more units in order to make credible the concept of controlled, escalatory warfare, even should that mean prolonged, controlled nuclear conflict, then it may develop that the computers used for many functions at base level will be required to be mobile and many functions normally performed at the base would move on short notice to remote locations during time of crisis or conflict.

Thus far, the comments on utility systems have centered primarily on systems that for the most part might be used in relatively benign environments, e.g., in the ZI. As indicated earlier, there appears to be a place for utility systems in the hands of tactical forces in the field and these systems would likely apply to the complete spectrum of

possible uses. Aboard ships, warning and control aircraft, and command post aircraft the local environment seems to favor the local utility concept to a considerable degree, primarily because of the ease with which the communications and security problems can be handled. For ground forces in the field, communications, security, and (perhaps most important) the vulnerability of one or a few central data processing locations tends to auger against the use of a utility system for even moderately large geographic areas. Within Army tactical operation centers and like points of management and control, the utility concept will likely be limited to a large central data processor and I/O stations in the immediate vicinity. In general, military operations in the field--by individual unit and often by function--are most apt to demand organic data processing equipment at many echelons to achieve the flexibility, security, and survivability needed.

DEVELOPMENT OF FUTURE SYSTEMS

The statements above can be construed to imply that much of the important structure of future military data automation systems is fuzzy at best. Also, one of the most important questions for all systems would seem to be: "Who gets the central processing units?" Some insight to this part of planning might be provided by well coordinated tri-service experimental tests. It is the writer's belief that the test should be carried out in the field (which may mean aboard ship, at a specified headquarters, a military base, in a test aircraft, etc.) and in conjunction with the potential users of the systems. In some cases it may be desirable to establish parallel development efforts, one at a field installation and one at a research or development center, with coordination ensured. Coordination is also required among the services, so that hardware and software advances by any service can be exploited as soon as possible wherever they are applicable.

Listed below are some features that might contribute to a workable, productive development and test program. Doubtless, other items could be added.

1. Top-level support, direction, and guidance. A tri-service program needs support from a cognizant DOD organization, from headquarters staff level in each service, and from the commander of the military organization providing facilities for the tests performed by user and development personnel.

2. A user group to support the test. Test success depends greatly on experienced, qualified personnel and for data automation in military tasks, a user organization is essential to test the utility of the system.

3. Expert help from contractors. To ensure optimal testing, hardware and software know-how provided by contractual support should be incorporated, but with control in the hands of the user, with appropriate guidance and assistance from development agencies.

4. Off-the-shelf equipment. Third-generation data automation equipment should be used when possible to provide operational experience that could lead to a better basis for determining more meaningful military requirements. It also would contribute to useful feedback and cross-fertilization among the services, the development agencies, and the planning structure in the DOD.

5. Test to serve at least one need thoroughly. A test need not attempt to serve all identifiable needs, but it should be directed toward the adequate solution of at least one outstanding task.

6. Data automation experiment as an aid not an end. Each test and each development effort should reflect the fact that data automation should be applied to aiding man in his military duties, rather than attempting to replace him.

7. Means for the exchange of experience and information. A series of on-site field tests and experiments involving user personnel can be most useful if all parties concerned are continuously kept informed of all parts of the test program. For example, an airborne data processing system applied to strategic command and control could have application also for ground and shipboard command and control systems and, more broadly, for other management and support systems where mobility and weight are of prime consideration. Furthermore, software techniques useful in command and control systems may find at least partial application in medical systems, and vice versa. Channels for publishing interim results, and meetings to exchange information and experience, should be frequent.

The seven points above represent, of course, but a beginning in the outline of a comprehensive field test and development program. Central to the entire theme, obviously, is the need for top-level coordination, whether the program is undertaken by a single service and its own agencies and commands, or whether it is handled on a DOD-wide basis. Properly coordinated at either level, the results of such a program would be of inestimable benefit to the planners of future systems.

V. POTENTIAL PITFALLS AND BOTTLENECKS IN PLANNING FOR FUTURE SYSTEMS

Although many of the points to be made below have been brought out elsewhere in this Paper, a few of the more important pitfalls and bottlenecks in master planning are explicitly noted here for convenience. Foremost among these is the possibility of lack of upper echelon guidance and coordination of master plans developed by lower levels of command. Planners at lower levels may find many months of effort turned aside by decisions made at higher levels concerning, for example, the manner in which utility systems may be used in the future. As another example, decisions concerning the use of data processing aboard most of the Navy's first-line ships or in the majority of the Army's ground units should be made in close conjunction between using commands and higher headquarters and coordinated throughout the DOD, as has been reiterated throughout this Paper.

Lack of field experimentation may prove to be a bottleneck in developing meaningful master plans. At the moment this comment applies equally to the question of the general military applicability of the utility system, as well as to the application of data automation to tactical functions.

In spite of the fact that communications technical feasibility is not in question, it may develop that certain communication systems will for a time be inadequate for the many data automation systems that may be scheduled for their use in master plans. Often the master planners at lower echelons look upon a communication system such as

might be found at base level or at higher level, such as AUTODIN, as the expected means for transmission of information. As was the case with the early users of AUTODIN, the data automation master planner may find, to his surprise and shock, that not only is much of the communication system's capacity being used by others but also that the system itself exhibits certain characteristics that seriously curtail effective data rate.

It may develop in newly applied data automation systems that the operational unit is inadequately organized and/or staffed to bring the system into full operational capability in the expected period of time. A pitfall of this kind can be expected as data automation is more widely applied to new functional areas such as those encompassed by the surgeon general, the inspector general, the judge advocate, etc. And it is likely to be even more prevalent in the application of data automation in the tactical area. Limited-scope field tests and experiments might tend to ease this potential bottleneck.

Two well-known workhorses conclude this list of pitfalls: one is standardization of data processing languages, and little more will be said except that it is needed, for it is getting attention today and it will doubtless require additional attention throughout the foreseeable future. The second well-known bottleneck is training: data automation training continues to be needed in all functional areas of application and at all levels of command. All master plans should include an adequate treatment of an accompanying training program. Fortunately, advances in computer software are leading to programming languages that are increasingly easier to master. And there is always the hope that new data automation systems will come equipped with a programmed learning feature, so that the operation, programming, and maintenance of the equipment can be learned in programmed fashion from the machine itself. A feature such as this would be of great benefit, if it could be made a part of tactical data automation systems, where the turnover of personnel in the unit may be high.

VI. SUGGESTIONS FOR FUTURE PLANNING

The central themes of this Paper are few and simple. In summary form, reworded as suggestions for future planning efforts, they might be as follows:

- In all master planning efforts, insist on receiving guidance and coordination from above and ensure that it is given to echelons below.
- Where experience for master planning is lacking, outline on-site, user-performed tests and experiments to provide the experience and insight required. In field tests, make use of existing hardware (and software, where possible) and contractor support, but keep the user in control.
- In planning for military data automation systems, do not lose sight of the need to keep military systems flexible and survivable; in the future this may impose requirements of redundancy and mobility on systems that today are considered to be of the fixed installation type.
- Keep in clear view the pitfalls and bottlenecks that may plague the data automation systems proposed in master plans and recognize that some of the difficulties may be alleviated by adequate organization and staffing of the operational units, by adequate training at all levels of command, and by communication systems that are compatible with the data processing system and adequate to serve all demands.

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